International Journal of Botany
and Research (IJBR)
ISSN (P): 2277–4815; ISSN (E): 2319–4456
Vol. 11, Issue 2, Dec 2021, 15–22

TRANS STELLAR
•Journal Publications •Research Consultancy

Original Article

CORRELATION AND PATH COEFFICIENT ANALYSIS FOR QUANTITATIVE TRAITS IN CHICKPEA (*CICER ARIETINUM* L)

ABRAHAM CHINNA RAJU & GAIBRIYAL M. LAL

Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, India

ABSTRACT

The present investigation entitled "Correlation and Path Coefficient Analysis of Quantitative Traits in chickpea (Cicer arietinum L.)" was conducted during rabi, 2020-2021. At the Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, twenty one genotypes, as well as a control, PUSA-362, were grown in the experiment. Three replications were used in this Randomized Block Design (RBD) experiment. For observation taken thirteen characters into consideration i.e. Days to 50% flowering, Days to 50% pod setting, plant height (cm), number of primary and secondary branches per plant, days to maturity, number of seeds per pod, number of pods per plant, number of seeds per plant, biological yield per plant (g), 100-seed weight (g), harvest index (%), seed yield per plant (g). All of the chickpea genotypes differed significantly from one another, and significance variability existed for all of the characters. Based, on mean performance, high yield was found for the IPC-11-85 followed by 04-01, ICCC-37, WCK-3, ICC-4958, PG-06102. For the number of pods per plant and the number of seeds per plant, substantial heritability (>70%) was observed, as well as high genetic progress (>20%). At both the genotypic and phenotypic levels, seed output per plant had a positive and highly significant connection with days to 50% pod setting and number of seeds per pod. Biological yield, harvest index, and quantity of seeds per plant were revealed as essential direct components for seed yield per plant using phenotypic analysis. The quantity of seeds per plant showed a high level of genetic progress. For biological yield, a high genetic advance as a percentage mean (>20%) was documented. Low GCV with high heritability coupled with high to medium genetic advance as percent mean was observed for the characters seed index, days to 50% pod setting, days to maturity, number of seeds per pod, days to 50% flowering. For biological yield, a high genetic advance as a percent mean (>20 percent) was reported. The number of secondary branches had the highest GCV, followed by biological yield (g). Hence, most importance should be given to these characters during selection for seed yield per plant.

KEYWORDS: Chickpea (Cicer arietinum), Correlation, Path Analysis, Genetic Advance, Variability & Yield

Received: Aug 01, 2021; **Accepted**: Aug 20, 2021; **Published**: Aug 31, 2021; **Paper Id**.: IJBRDEC20213

INTRODUCTION

Pulses are a large group of food crops that are unique in world agriculture due to their high protein content. High sensitivity and widespread usage of pulses in Indian diets are the most common rabi crop and meet around 30% of day-to-day requirements for protein. This high area under cultivation and production is in Madhya Pradesh, then Rajasthan, Maharashtra, Uttar Pradesh and Andhra Pradesh. These districts in Uttar Pradesh, which account for almost 55 percent of state chickpea production, are main producing districts such as Banda, Hamirpur, Jhansi, Lalitpur, Mahoba and Chitrakoot, and are all the primary producing districts under the Bundelkhand area. After the world's beans Chickpea was second with a planted area of 13.9 million hectares and a production of 13.7 million

tonnes. In India area of chickpea is 96.9 Lakh ha, production 110.78lakh tons and productivity is 1142 kg/ha. In Uttar Pradesh area of chickpea is 6.21lakh ha, production is 8.51 lakh tons and productivity is 1371 kg/ha. The ultimate objective of the breeding programme is yield, with the most significant feature being seed yield. As a result of the multiple physiological changes that affect seed output within the plant and many external conditions, the breeder needs certain index features in order to choose elite genotypes for better yields. Genetic variation between trait types, however, is necessary for determination of the selection criteria; path coefficient analysis, however, helps to assess the direct effect of traits and their indirect effect on their features. In addition, the analysis of pathway coefficients is essential for determinations of the seed yield and the yield components. Furthermore, the direct effects of one variable on the other are measured in the route coefficient analysis and the correlation coefficients can be divided into direct or indirect components. The correlation does not give a suitable representation of the relationship between variables. The possibility to split the correlation factor into its components is very significant in this investigation (Dewey & Lu 1959).

MATERIALS AND METHODS

This experiment was carried out at the Field Experimentation Centre, Naini Agriculture Institute, the University of Agriculture, Technology and Science in Prayagraj, the University of Uttar Pradesh, and the Department of Genetics and Plant Cleaning. The experiment consists of 21 genotypes including check (PUSA 362), sown on 7th November, 2021. All the cultural practices were practised according to necessity. Comments were recorded Blossoming up to 50% by days. Days settings to 50% pods. Plant height (cm). Number of main branches of plants. Number of sub-plants branches. Maturity number of days. Pods by number of plant. Pot quantity of seeds. Amount of seeds of plants. Biological yield per plant (g). 100 seed weight (g). Harvest index (%). Seed yield per plant (g). Here, Days to 50% pod setting, Days to 50% flowering, Days to maturity were recorded crop wise whereas all other traits were recorded for randomly selected plants. Mean values of all genotypes have been assessed to estimate Fisher's level of importance (1936). Genetic parameters were calculated by the method suggested by Burton(1952). Correlation Coefficient was subjected by the data obtained for various traits by the method Al Jibouri *et al.,* (1958) and path Coefficient analysis by the method suggested by Dewy and Lu (1959).

RESULTS AND DISCUSSION

The Analysis of Variance showed various differences among the genotypes which indicate significant variation for the traits in all twenty genotypes of chickpea.

Estimation of Genetic Parameters

For each character in genotypes, phenotypes, phenotypes, variations, heritage, genetic progress and genetics as a proportion of the average figure, estimates were made accessible (table 1). In the current study (Table 1), it has been revealed that in general estimates the matching variation coefficient of the phenotypically coefficient has been exceeded, which suggests the impact of environmental effects on their expression. The coefficient of genotypical variation ranged between 1815 (days and 50% pods) and 30.38. (number of secondary branches per plant). Phenotypic coefficient of variation varied from 3.251 (days to 50% pod setting) to biological yield (31.48).

Burton (1952) argued that a better notion of the planned selective effectiveness is given to genetic diversity and patrimony. A character with a high GCV and a high inheritance is therefore useful in a selection programme. The estimate of heritability from the present investigation is presented below Heritability varied from 31.2 (days to 50% flowering, days

to 50% pod setting, days to maturity) to 95.6 (number of pods per plant). The high magnitude of variability was recorded for number of pods per plant (95.6), number of secondary branches (94.8), biological yield (92.5), number of seeds per plant (90.5), seed yield per plant (86.1), number of seeds per pod (83.9), 100 seed weight (82.2). Traits with high heritability estimates in the broadest sense can be used for the enhancement of genetics because they have the least impact on the environment. Features with high heritability estimates can be used to improve genetics in the wider sense because they have the least environmental impact.

Genetic advance varies from 0.325 (number of primary branches) to 30.876 (number of seeds per plant). The high genetic progress for plant seed (30.876), plant count, has been documented (29.014). Genetic advance as percentage of mean varies from 2.088 (days to 50% flowering) to 60.949 (number of secondary branches). Significant genetic gains were reported in a mean proportion for the number (60,949) of secondary branches, biological yield in grammes (60,018) and number of plants (59.04).

Estimation of Correlation Coefficient

Correlation analyses the mutual links between the various plant properties and identifies the rates on which genetic rates can be improved. In the present investigation, attempt has been made to estimate the phenotypic and genotypic correlation coefficient in all the characters combinations with the objective to get the information about the nature, extent and direction of the relationship and selection pressure process to achieve practical and usable results. High magnitude of positive correlation coefficient at genotypic level indicates strong linkage at a genetic level, but high values of correlation coefficient at phenotypic levels always may not always show a strong association. Correlation coefficient studies showed that most of characters pairs, phenotypic and genotypic associations were higher than the corresponding phenotypic ones, indicating an inherited association between the characters. Plants show significant positive relationships between plant yields, plant numbers, numbers of primary branches, seed per pot, plant yields, biological output per plant, weight 100 seeds, plant heights of phenotypes and genotype levels. plants also have significant positive relationships with the plant. Seed yields, seed per plant, are the most essential economic criteria. The estimates of genotypic correlation coefficient with yield showed a similar trend to those of phenotypic correlation coefficient in direction. However, these were higher in magnitude. It suggests that these correlation coefficients were due to breeding values and therefore, more dependable. Similar results were in accordance with the findings of Durga *et al.,* (2007), Malik *et al.,* (2010), Jha *et al.,* (2012), Kuldeep *al.,* (2014), Babbar*et al.,* (2015), Salgotra*et al.,* (2016), Agarwal *et al.,* (2018), Hailu *et al.,*(2019).

Estimation of Path Coefficient Analysis

Dewey and Lu (1959) presented the coefficient of path analysis, which splits the coefficient into direct and indirect effect measurements and is a standardised coefficient of regression. The effect of many independent parameters on dependent qualities such as seed return per plan is measured directly and indirectly. The results of this study reveal that each plant and harvest index has a considerable positive direct effect on seed output. The seed production coefficient per plant has a favourable connection between the two attributes. Thus the creation of seed by plant and organic production by plant are really interconnected. The findings from the route analysis showed that the plant yields are strongly positive and highly directly beneficial, particularly the biological yields for the plant yield index. The results were in confirmations with the findings of Jeena *et al.,*(2002), Narayana *et al.,* (2002), Renukadevi *et al* (2006), Gohil *et al.,* (2010), Khan *et al.,* (2016), Dev *et al.,* (2017), Nitesh *et al.,*(2018), Gediya*et al.,* (2019), Agarwal *et al.,* (2020).

Table 1: Analysis of Variance for 13 Quantitative Characters of 21 Chick Pea Genotypes During Rabi-2020-21

Source of Variations	Mean Sum of Squares		
	Replicate	Treatments	Error
DF	2	20	40
Days to 50% flowering	8.495	65.803 *	27.907
Days to 50% pod setting	8.16	19.329 *	8.191
Plant height (cm)	2.367	157.602 ***	13.648
Number of primary branches	0.095 *	0.150 ***	0.027
Number of secondary branches	0.535 **	5.809 ***	0.103
Days to maturity	10.134	113.641 *	48.173
Number of seeds per plant	134.169 **	770.232 ***	25.906
Number of pods per plant	49.596 **	632.094 ***	9.56
Number of seeds per pod	0.022	0.334 ***	0.02
Biological yield (g)	29.747 **	219.576 ***	5.738
100 Seed weight (g)	3.482	51.172 ***	3.447
Harvest index (%)	84.877 **	63.614 ***	16.367
Seed yield per plant (g)	8.892 *	33.740 ***	1.723
*indicates 5% level of significance **indicates 1% level of significance ***indicates 0.1% level of significance			

Table 2: Estimation of Genetic Parameters for 13 Quantitative Characters in Twenty One Chick Pea Genotypes

S. no	Character	GCV	PCV	h2(bs) (%)	GA	GA as % Mean
1.	Days to 50% flowering	3.911	7.006	31.2	4.087	4.498
2.	Days to 50% pod setting	1.815	3.251	31.2	2.217	2.088
3.	Plant height (cm)	11.254	12.754	77.9	12.591	20.455
4.	Number of primary branches	8.398	10.779	60.7	0.325	13.478
5.	Number of secondary branches	30.38	31.194	94.8	2.67	60.949
6.	Days to maturity	3.639	6.517	31.2	5.373	4.185
7.	Number of seeds per plant	25.372	26.663	90.5	30.876	49.734
8.	Number of pods per plant	29.313	29.981	95.6	29.014	59.04
9.	Number of seeds per pod	22.393	24.451	83.9	0.611	42.248
10.	Biological yield (gm)	30.285	31.48	92.5	16.732	60.018
11.	Harvest index (%)	7.939	11.337	49	5.725	11.452
12.	100 Seed weight (gm)	20.183	22.263	82.2	7.449	37.694
13.	Seed yield per plant	24.148	26.024	86.1	6.244	46.157

Table 3: Phenotypic and Genotypic Correlation Coefficient for 13 Quantitative Traits of Chick Pea

Characters		Days to 50% Flowering	Days to 50% pod Setting	Plant Height (cm)	Number of primary Branches	Number of Secondary Branches	Days to Maturity	Number of Seeds per Plant	Number of Pods per Plant	Number of Seeds per pod	Biological Yield (g)	100 Seed Weight (g)	Harvest Index (%)	Seed Yield per Plant gms
Days to 50% flowering	P	1	0.4005**	-0.1275	0.1086	-0.1276	-0.0448	-0.0111	-0.0934	0.1894	-0.1105	-0.0543	0.1181	-0.076
	G	1	0.925**	-0.327**	0.15	-0.1393	-0.248*	-0.0465	-0.2036	0.443**	-0.271*	-0.1644	0.1805	-0.258*
Days to 50% pod setting	P		1	-0.0421	-0.0938	0.0258	0.0184	0.1189	0.1443	-0.0329	0.2097	0.1819	-0.22	0.166
	G		1	-0.15	-0.303*	0.162	0.499**	0.146	0.2136	-0.081	0.272*	0.273*	-0.186	0.329**
Plant height (cm)	P			1	0.0071	0.0671	0.2834 *	0.3233 **	0.2794 *	-0.1883	0.4219 ***	-0.0199	-0.3023 *	0.386**
	G			1	-0.097	0.067	0.579**	0.372**	0.335**	-0.156	0.488**	-0.059	-0.406**	0.435**
Number of primary branches	P				1	0.2412	-0.2630 *	0.2313	0.3166 *	-0.0771	0.1124	-0.063	0.0847	0.201
	G				1	0.225	-0.681**	0.262*	0.391**	-0.035	0.073	-0.205	0.332**	0.198
Number of secondary branches	P					1	0.1664	0.2825 *	0.3938 **	-0.2078	0.5373***	0.3976 **	-0.1689	0.576**
	G					1	0.303*	0.301*	0.421**	-0.219	0.578**	0.433**	-0.305*	0.613**
Days to maturity	P						1	0.1285	0.0377	-0.0368	0.3698 **	0.1951	-0.1578	0.304*
	G						1	0.236	0.0958	0.068	0.648**	0.303*	-0.434**	0.539**
Number of seeds per plant	P							1	0.8758 ***	0.2682 *	0.6935	-0.3681 **	-0.1619	0.748**
	G							1	0.897**	0.314*	0.698**	-0.439**	-0.141	0.788**
Number of pods per plant	P								1	-0.1132	0.7859***	-0.1206	-0.2919*	0.817**
	G								1	-0.125	0.789**	-0.151	-0.345**	0.866**
Number of seeds per pod	P									1	-0.2194	-0.6122 ***	0.2942 *	-0.16
	G									1	-0.21	-0.659**	0.367**	-0.153
Biological yield (g)	P										1	0.2855 *	-0.5695	0.925**
	G										1	0.285*	-0.708**	0.978**
100 Seed weight (g)	P											1	-0.3569**	0.233
	G											1	-0.490**	0.23
Harvest index (%)	P												1	-0.333**
	G												1	-0.534**
Seed yield per plant gms	P													1
	G													1

Table 4: Phenotypic and Genotypic path Coefficient for yield Contributing Traits of Chick Pea Evaluated During Rabi 2020-21

Characters		Days to 50% flowering	Days to 50% pod setting	Plant height (cm)	Number of primary branches	Number of secondary branches	Days to maturity	Number of seeds per plant	Number of pods per plant	Number of seeds per pod	Biological yield (g)	100 Seed weight (g)	Harvest index (%)	Seed yield per plant (gms)
Days to 50% flowering	P	0.015	0.006	-0.0019	0.0016	-0.0019	-0.0007	-0.0002	-0.0014	0.0028	-0.0017	-0.0008	0.0018	-0.076
	G	0.0876	0.098	-0.0286	0.0131	-0.0122	-0.0218	-0.0041	-0.0178	0.0389	-0.0237	-0.0144	0.0158	-0.2579
Days to 50% pod setting	P	-0.0093	-0.0231	0.001	0.0022	-0.0006	-0.0004	-0.0027	-0.0033	0.0008	-0.0048	-0.0042	0.0051	0.166
	G	-0.0938	-0.0838	0.0125	0.0254	-0.0135	-0.0419	-0.0123	-0.0179	0.0068	-0.0228	-0.0229	0.0156	0.3294
Plant height (cm)	P	-0.0088	-0.0029	0.069	0.0005	0.0046	0.0195	0.0223	0.0193	-0.013	0.0291	-0.0014	-0.0209	0.386**
	G	-0.0138	-0.0063	0.0423	-0.0041	0.0028	0.0245	0.0158	0.0142	-0.0066	0.0207	-0.0025	-0.0172	0.4351
Number of primary branches	P	0.0006	-0.0005	0	0.0057	0.0014	-0.0015	0.0013	0.0018	-0.0004	0.0006	-0.0004	0.0005	0.201
	G	-0.0089	0.0179	0.0057	-0.0593	-0.0133	0.0403	-0.0155	-0.0231	0.0021	-0.0043	0.0122	-0.0197	0.1977
Number of secondary branches	P	-0.0044	0.0009	0.0023	0.0083	0.0344	0.0057	0.0097	0.0135	-0.0071	0.0185	0.0137	-0.0058	0.576**
	G	0.0055	-0.0064	-0.0026	-0.0089	-0.0395	-0.012	-0.0119	-0.0166	0.0087	-0.0228	-0.0171	0.012	0.6129
Days to maturity	P	0.0006	-0.0002	-0.0038	0.0035	-0.0022	-0.0133	-0.0017	-0.0005	0.0005	-0.0049	-0.0026	0.0021	0.304*
	G	0.027	-0.0543	-0.0629	0.074	-0.033	-0.1087	-0.0257	-0.0104	-0.0074	-0.0704	-0.033	0.0472	0.5392
Number of seeds per plant	P	-0.0025	0.0272	0.0741	0.053	0.0647	0.0294	0.2291	0.2007	0.0615	0.1589	-0.0843	-0.0371	0.748**
	G	-0.0399	0.1254	0.3193	0.2245	0.2581	0.2024	0.8574	0.7693	0.269	0.5987	-0.3766	-0.1213	0.788
Number of pods per plant	P	-0.0152	0.0235	0.0456	0.0517	0.0642	0.0062	0.1429	0.1632	-0.0185	0.1282	-0.0197	-0.0476	0.817**
	G	0.0419	-0.0439	-0.0689	-0.0803	-0.0866	-0.0197	-0.1845	-0.2056	0.0257	-0.1623	0.031	0.0709	0.8661
Number of seeds per pod	P	0.0091	-0.0016	-0.0091	-0.0037	-0.01	-0.0018	0.0129	-0.0055	0.0483	-0.0106	-0.0296	0.0142	-0.16
	G	-0.0427	0.0078	0.015	0.0034	0.0211	-0.0066	-0.0302	0.012	-0.0963	0.0202	0.0634	-0.0353	-0.1527
Biological yield (g)	P	-0.0738	0.1401	0.2818	0.0751	0.3589	0.247	0.4632	0.525	-0.1466	0.668	0.1907	-0.3804	0.925**
	G	-0.1739	0.1743	0.3137	0.0469	0.3713	0.416	0.4484	0.5068	-0.1346	0.6422	0.1833	-0.4546	0.9783
100 Seed weight (g)	P	-0.0137	0.0458	-0.005	-0.0159	0.1002	0.0492	-0.0928	-0.0304	-0.1543	0.072	0.252	-0.0899	0.233
	G	-0.0828	0.1376	-0.0296	-0.1033	0.2182	0.1529	-0.2213	-0.0759	-0.3318	0.1438	0.5039	-0.2467	0.2298
Harvest index (%)	P	0.0266	-0.0495	-0.0681	0.0191	-0.038	-0.0355	-0.0365	-0.0657	0.0663	-0.1282	-0.0804	0.2252	-0.333**
	G	0.0359	-0.037	-0.0807	0.0661	-0.0607	-0.0864	-0.0282	-0.0686	0.073	-0.1409	-0.0975	0.1991	-0.5341
Seed yield per pla	P	-0.076	0.166	0.386**	0.201	0.576**	0.304*	0.748**	0.817**	-0.16	0.925**	0.233	-0.333**	1
	G	-0.2579	0.3294	0.4351	0.1977	0.6129	0.5392	0.788	0.8661	-0.1527	0.9783	0.2298	-0.5341	1
Partial R^2	P	-0.0011	-0.0038	0.0266	0.0011	0.0198	-0.004	0.1713	0.1332	-0.0077	0.6179	0.0587	-0.075	
	G	-0.0226	-0.0276	0.0184	-0.0117	-0.0242	-0.0586	0.6757	-0.1781	0.0147	0.6282	0.1158	-0.1063	

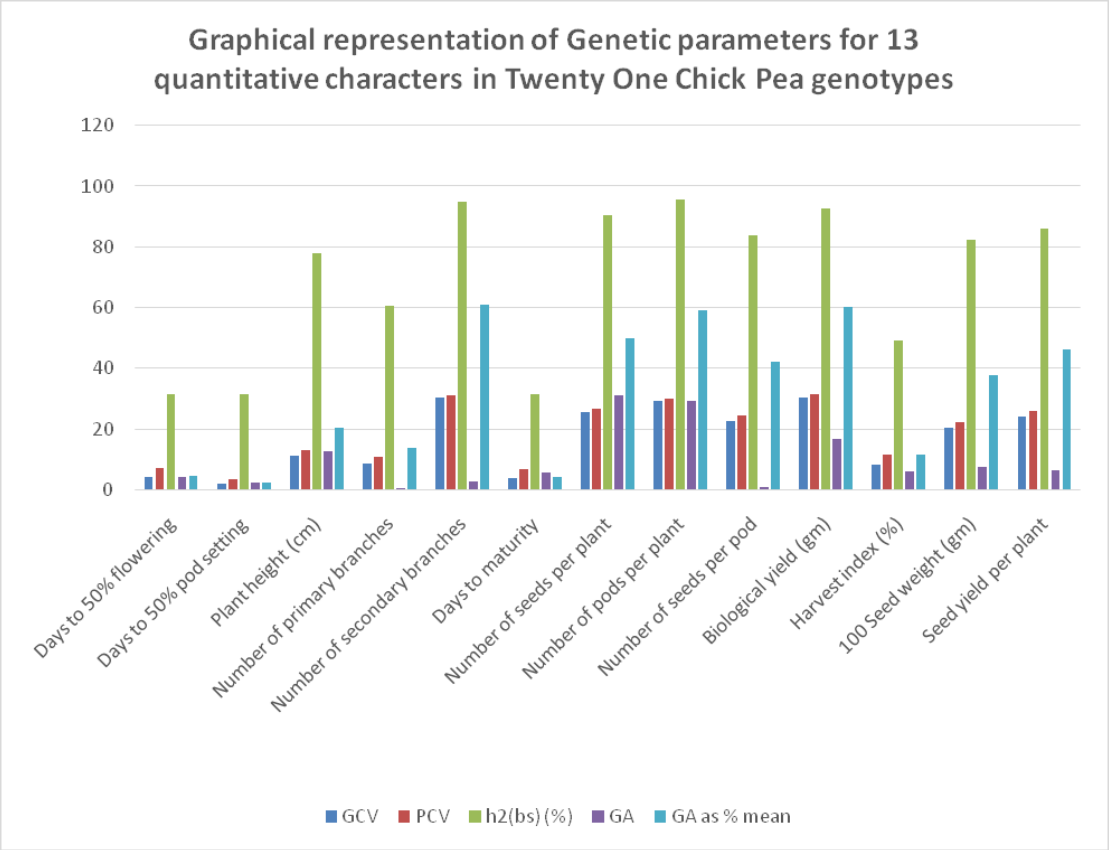

Figure 1

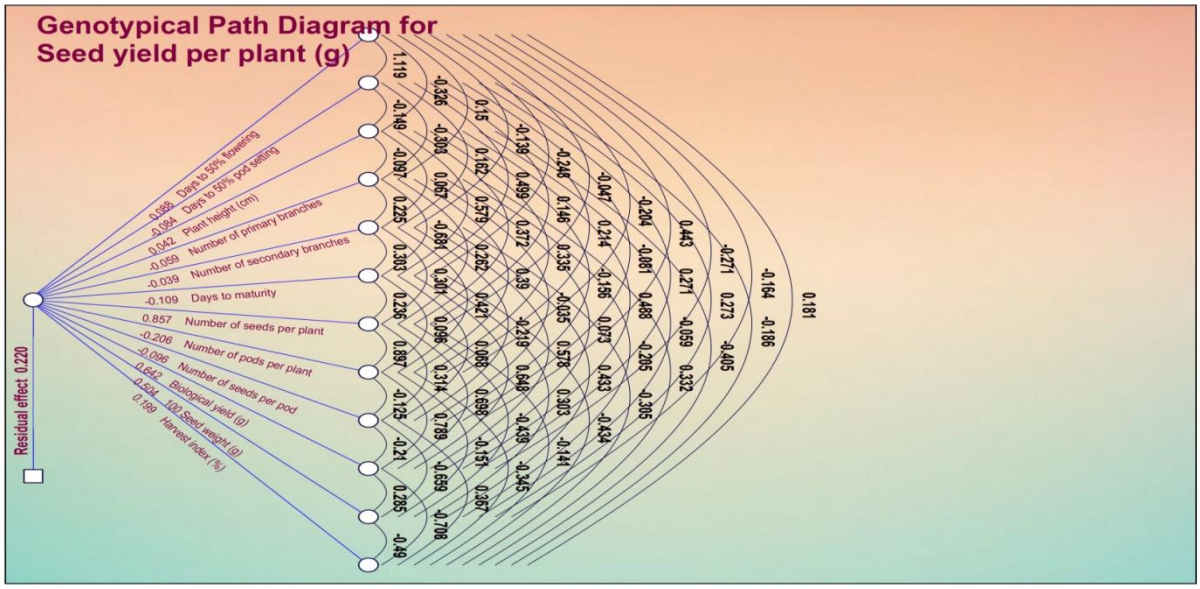

Figure 2: Genotypic Path for Quantitative Traits of Chick Pea.

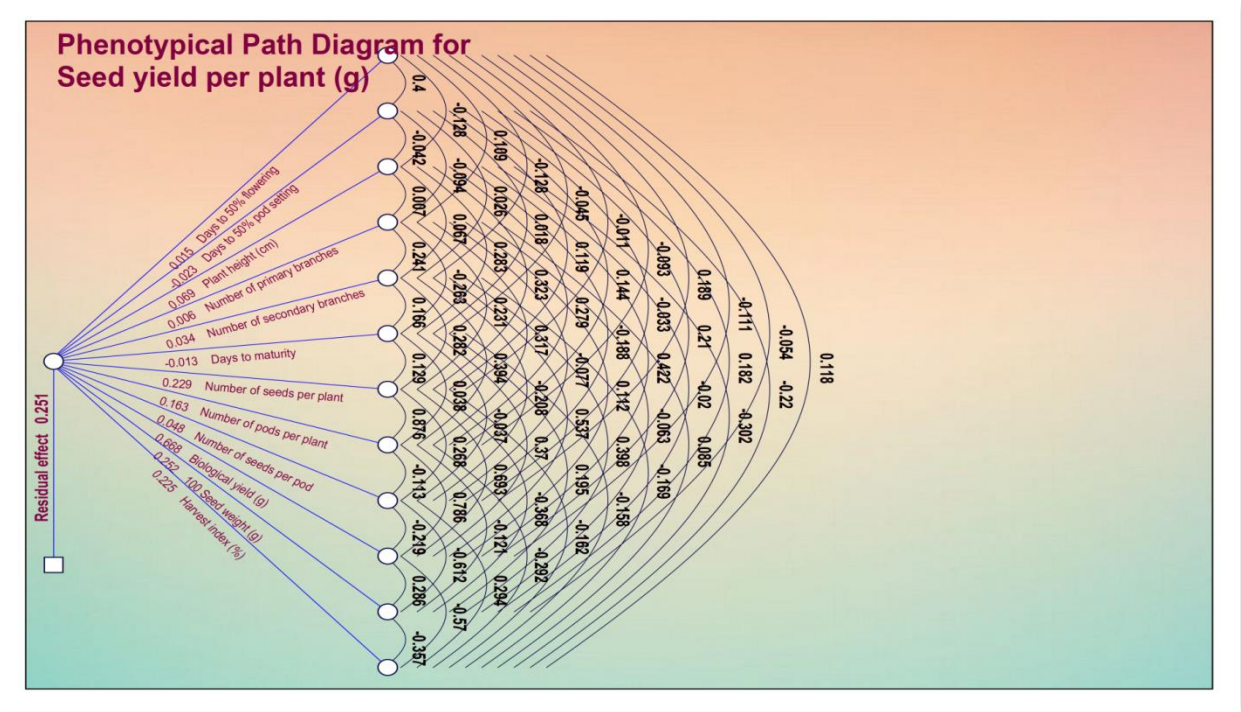

Figure 3: Phenotypic Path for Quantitative Traits of Chick Pea.

CONCLUSIONS

The present investigation concludes that among 21 genotypes of chick pea based on mean performances IPC-11-85 was found to be superior in grain over the check followed by 04-01. Genetic parameters revealed that heritability and genetic advance as % mean values for Biological yield, Number of secondary branches, Number of pods per plant, Number of seeds per plant. Correlation coefficient investigations have indicated that the seed production by plant is good and large, as does the number and biological output of genotypes and phenotypes per plant.. Path coefficient studies have shown the positive direct impact, genotype seed yield, phenotypical levels, days to 50% pods, plant heights, secondary branches, plant number, maturity and organic yields, etc. The path coefficient study has shown positive direct impact on plant yield. For these characteristics, it is very crucial to pick seed yields per plant.

REFERENCES

1. *Agarwal, T., Kumar, A., Kumar, S., Kumar, R. R., Kumar, S. and Singh, P.K. (2018). Correlation and Path Coefficient Analysis for grain yield and yield components in chickpea (Cicer arietinum L.). Under normal and late sown conditions of Bihar, India. International Journal of Current Microbiology and Applied Sciences, 7(2): 1633-1642.*
2. *Ali, Q.M., Mishra, Singh and Kumar (2011). Exploitation of genetic variability of grain yield improvement in chickpea. International Journal of Agriculture and Biology, 4(1): 149-152.*
3. *Arora, P.P., and Kumar, L. (1994). Correlation coefficient and path coefficient analysis in Chickpea (Cicer arietinum L.). Indian Journal of Pulse Research., 7(2): 177-178.*
4. *Arora, P.P., and Kumar, L. (1995). Path coefficient analysis in chickpea. Indian Journal of Pulse Research., 8(3): 133-134.*
5. *Babbar, A. and Patel, S.K. (2010). Correlation and path analysis in desi chickpea under Kymore Plateau Zone of Madhya Pradesh. Research Journal 39(1): 47-51.*

6. *Bhaduoria, P., Chaturvedi, S.K. and Awasthi, N.N.C. (2003). Character association and path coefficient analysis in chickpea (Cicer arietinum L.). Ann. Agricultural Research.,24(3): 684-685.*
7. *Gediya, L.N., Patel, D.A., Kumar, D., Parmar, D.J., Patel, S.S. (2019)Phenotypic variability, path analysis and molecular diversity analysis in Chickpea (Cicer arietinum L.) Vegetos32(1): 167-180.*
8. *Hagos, Assefa, A., Tadesse, D. and Tesfay, B. (2018). Genetic variability, correlation and path analysis for quantitative traits of seed yield, and yield components in chickpea (Cicer arietinum L.) at Maichew, Northern Ethiopia. African Journal of Plant Science, 12(13): 58-64.*
9. *Hailu. and Fasil. (2020). Genetic Variability, Heritability and Genetic Advance of Kabuli chickpea (Cicer arietinum L.) for agronomic traits at central Ethiopia. International Journal of Plant Breeding and Crop Science, 7(1): 710-714.*
10. *Jeena, A.S., P.P. (2002). Path analysis in relation to selection in Chickpea (Cicer arietinum L.). Agril. Sci. Digest, 22(2): 132-133.*
11. *Khan, H., Ahmad, S.Q., Ahmad, F., Khan, M.S. and Nayyar, I. (2006). Genetic variability and correlation among quantitative traits in grain. Sarhad Journal of Agriculture., 22(1): 55-59.*
12. *Kumar, V., Kar, C.S., Sharma, P.C. and Kumar, V. (1999). Variability, correlation and path coefficient analysis in Chickpea (Cicer arietinum L.). Environmental and Ecology, 17(4): 936-939.*
13. *Kuldeep, R. K., Pandey, S., Babbar, A. and Mishra, D. K. (2014). Genetic variability, character association and path coefficient analysis in chickpea under heat stress condition. Electronic Journal of Plant Breeding, 5(4): 812-819.*
14. *Narayana, H.S.and Reddy, N.S. (2002). Correlation path analysis in chickpea (Cicer arietinum L.). Journal of Research ANGRU, 30(1): 29-33.*
15. *Renukadevi, P.and Subbalakshmi, B. (2006). Correlation and path coefficient analysis in chickpea. Legume Research, 29(3): 201-204.*
16. *Shashikumar, K. T., and M. Pitchaimuthu. "Heterosis and combining ability analysis of quantitative and qualitative traits in muskmelon (Cucumis melo L)." International Journal of Agricultural Science 6 (2016): 341-348.*
17. *Kumar, Sudhir, et al. "Study of CGMS based pigeonpea [Cajanus cajan (L.) Millsp] hybrids in terms of combining ability." Int. J. of Agri. Sci and Res.(IJASR) (2017): 129-134.*
18. *Kumari, S. Surya, et al. "Genetic divergence and combining ability studies for exploitation of heterosis in paprika (Capsicum annuum L.)." International journal of agricultural science and research 4.2 (2014): 59-66.*
19. *Panja, Sudeshna, et al. "Effect of water stress at tillering stage on different morphological traits of rice (Oryza sativa L.) genotypes." International Journal of Agricultural Science and Research (IJASR) 7.3 (2017): 471-480.*